

designs. Designing for space is clearly limited by the availability of space grade components and constraints which can lead to the use of sometimes rather strange techniques.

Notes

¹ ESA ECSS standards for space missions, ecss.nl/standards/.

² P. Das, D. Shklarsky and L.B. Milstein, "SAW implemented real-time Hilbert transform and its application in SSB, *IEEE Ultrasonics Symposium*, 1979, pp 752-756.

³ The Actel RTAX FPGA, RTAX2000S-CQ352V (V-flow), www.microsemi.com/products/fpga-soc/radtolerant-fpgas/rtax-s-sl9.

⁴ Texas Instruments Digital to Analog Converter, DAC5675A-SP.

⁵ Minicircuits ZX95-2500W+ VCO, 194.75.38.69/pdfs/ZX95-2500W+.pdf.

⁶ Space grade products of Teledyne; www.teledynemicrowave.com/index.php/teledyne-microwave-space/microwave-solutions-space.

⁷ Frequency synthesizer of Analog Devices (1 – 7 GHz) ADF4180(S); www.analog.com/media/en/technical-documentation/data-sheets/adf4108.pdf (commercial version) and www.analog.com/en/products/clock-and-timing/phase-locked-loop/integer-n-pll/adf4108s.html (space grade model).


⁸ Teledyne/E2V/Peregrine prescalers; www.e2v.com/products/semiconductors/peregrine/.

⁹ The PIC microcontroller (PIC18F46J50) of Microchip; ww1.microchip.com/downloads/en/DeviceDoc/39931b.pdf.

¹⁰ E. Dekemper et al., "ALTIUS: a Spaceborne AOTF-based UV-VIS-NIR Hyperspectral Imager for Atmospheric Remote Sensing," *Proceedings Of SPIE*, 9241-92410L(1-10), 2014.

¹¹ I.C. Change, "Noncollinear Acousto-Optic Filter with Large Angular Aperture," *Applied Physics Letters* 25, 1974, pp. 370-372, doi: [dx.doi.org/10.1063/1.1655512](https://doi.org/10.1063/1.1655512).

Bibliography

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DM31 Activation, Organ Pipe Cactus National Monument

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Among satellite operators who are interested in confirming contacts with the 488 grids making up the continental USA, grid DM31 is one of the rarest grids. Most of DM31 lies in Mexico, where there aren't any operators working satellites or any VHF/UHF bands. The northeast corner of DM31 extends into southern Arizona around the Organ Pipe Cactus National Monument and the town of Lukeville. For most who wish to operate from DM31, the Arizona portion of the grid is the destination for any grid expeditions. I have done this several times since 2009, doing my part to put this grid on the satellites. On 2 February 2019, a Saturday, I made another excursion out to DM31 for a day of satellite operating. This was my first trip to DM31 in almost a year after my last trip in mid-February 2018, and it was the busiest of any of my DM31 trips.

Before going on the road, I prepared a list of passes I could work from DM31 on satellites in FM, SSB, and packet. AO-85 had been back in operation for a few days, meaning all 4 FM satellites should be available for passes. With the CAS-4 and XW-2 satellites, there was no shortage of passes I could work in SSB. FalconSat-3 passes were happening during the daytime, and a pleasant surprise

happened while I was in DM31 – the ISS digipeater was active once again, after several weeks of being unavailable. I made sure I had the right mix of radios to work all of these passes... an Icom IC-2730 dual-band mobile radio for the FM satellites, a pair of Yaesu FT-817NDs for SSB, and two different radios for the packet digipeaters (Kenwood TH-D72 for FalconSat-3, Kenwood TH-D74 for the ISS), and an Elk log periodic antenna. I packed a lunch, since the options for getting a meal out there are few – a convenience store and restaurant at the border, or other convenience stores and a small casino about 25 to 30 miles to the north. The nearest fast-food restaurant was over an hour away to the north, at Gila Bend along Interstate 8.

The Organ Pipe Cactus National Monument is in southern Arizona, a 2.5- to 3-hour drive from the Phoenix area. I had initially planned to get out to DM31 around 9am (1600 UTC), in time for an AO-92 pass. The list of passes I prepared showed a SO-50 pass just after 1430 UTC, a pass favoring the eastern half of the continental USA. With this in mind, I changed my departure time to around 1200 UTC.

With no traffic around Phoenix at that hour on a Saturday morning, and no rain to slow traffic on the way to DM31, I made the drive to DM31 in about 2.5 hours. I parked near the national monument's visitor center a few miles north of the U.S./Mexico border and had a few minutes to prepare for that SO-50 pass. I took some pictures of the radio and antenna on my car, along with a GPS receiver to document my location. When SO-50 came up over the hills to the north,



The author's portable station: 2 Yaesu FT-817NDs, Kenwood TH-D74 and TH-D72, ICOM- 2730, Elk log periodic antenna.





QTH at DM 31.



one in California. AO-85 came up just after XW-2A, but was in safe mode. Then I had two FM passes that overlapped - a low AO-92 pass to the east lasting 6 minutes, and a SO-50 pass that went almost directly over me lasting 13 minutes. I decided to work the AO-92 pass, and then switch over to SO-50 once AO-92 went away.

AO-92 was, as expected, busy for a Saturday morning. Once I could hear the downlink, I called the first station I clearly heard: Tanner, W9TWJ, in Texas. Once I made that QSO, the contacts started to flow from Texas and Oklahoma to the east coast. Near the end of the pass, I heard Jose, YS1MS, in El Salvador, and I made a QSO with not much time remaining on that pass. Ten QSOs went in the log on this AO-92 pass, and now I quickly dialed up the frequencies

for SO-50, so I could jump on the last half of the SO-50 pass. In about 5 minutes on SO-50, 8 more QSOs went in the log. I had already worked 5 passes, making QSOs on 4 of those 5 passes, and logging 30 QSOs in 2 hours — a great start for the day.

I had two passes in the 1700 UTC hour: CAS-4A at 1710 UTC, followed by AO-92 just before 1800 UTC. Three QSOs were logged on CAS-4A, with a light sprinkling of rain during the pass, the only rain I saw in DM31. On the AO-92 pass, 12 QSOs were logged. Despite the crowd on AO-92, this western pass was orderly. Two of the 12 stations I worked were new operators from the Phoenix area I hadn't heard before: K3TP in grid DM33, and AF7IN in grid DM43.

Border crossing at Lukeville, AZ.

I was able to make a quick contact with Jeff, WB8RJY, in Michigan for my first DM31 contact of the day. I logged six other QSOs during this pass, for a good start to the day.

After SO-50 went away, I had over an hour until the next pass, XW-2A at 1600 UTC. I took a quick drive to the USA/Mexico border for some pictures of the border crossing - the town of Lukeville on the Arizona side, and the city of Sonoyta in the Mexican state of Sonora across the fence - before returning to the visitor center for a stamp to have additional proof I was at the national monument. I parked in the same spot I used for the earlier SO-50 pass and stayed there for the rest of the time I operated from DM31.

When XW-2A came up at 1600 UTC, this turned out to be my busiest SSB pass of the day. I logged QSOs with 5 different stations - two in Texas, two in Arizona, and

Stations worked by WD9EWK from DM31 via FalconSat-3 on 2 February 2019



The 1800 UTC hour saw 4 passes: SO-50 at the top of the hour, AO-91 around the bottom of the hour, followed by FalconSat-3 and another CAS-4A pass. The SO-50 pass was a low pass to my west, with maximum elevation of only 9 degrees. I didn't hear anyone else on there. AO-91 passes around this time of day are busy, any day of the week. This Saturday in DM31 was no exception. With some work, three of the first 4 stations I worked on the AO-91 pass were in Central America - HP2VX, YS1MS, and TI2VLM. I was happy to get DM31 in the logs of these stations. After those stations, I was able to work XE2IMA in northeastern Mexico and seven other stations from coast to coast across the continental USA, for a total of 12 QSOs on AO-91. A couple of minutes later, FalconSat-3 came up from the west, and I was ready to go with my TH-D72. I saw three other stations on the 79-degree pass - KB6LTY in California, N7NEV in Arizona, and KB6IGK in Texas - and completed QSOs with each of them using APRS messages. When FalconSat-3 went away, CAS-4A was coming by again. I worked 4 stations from California to Texas on CAS-4A, wrapping up just before 1900 UTC for lunch.

At midday (1900 UTC), I had already worked 11 passes in 4.5 hours. I logged 64 QSOs on 9 of those 11 passes. I had previously worked passes in all 3 modes (FM, SSB, packet), and took a break before getting on the radio for the afternoon. I had some lunch and was visited by a pair of U.S. Park Rangers patrolling the national monument while eating lunch. One of these two rangers said his father is an amateur radio operator, and had some idea what I was doing out there. I was asked if I could track animals with the radios and antenna I had. I answered that I could track animals, but - from an encounter with a ranger on a previous trip to DM31 - I knew the answer to that question: no, I wasn't going to track animals. Doing that in a national park or monument, when not participating in a recognized research project with the National Park Service, is a federal felony.

While eating lunch, I had heard that the ISS packet digipeater came on earlier in the day. I had included ISS passes in the list of passes I had with me, and quickly put the DM31 information into the TH-D74 in time for a pass just before 2000 UTC - an 11-degree pass, going across the southeastern sky. For some reason, I was unable to get my position packets through the ISS digipeater and received a couple of RS0ISS status packets. I have worked the ISS digipeater on a past trip to DM31, and it appeared that the packet

system was deaf. I hoped I could do better on the next ISS pass, a 45-degree pass, and got ready to work more passes.

Just after 2000 UTC, AO-91 made another appearance. A 47-degree pass slightly to the west, I worked 12 stations up and down the west coast and into central and western Canada. FalconSat-3 came by again, and I worked the only other station I saw (N7NEV), followed by two more QSOs on another CAS-4A pass.

From this point until sunset around 0100 UTC, things were slowing down. I was still working passes, but only logging contacts with one to four stations on each pass. The ISS came by again just after 2130 UTC, and I was able to get through the digipeater for one QSO with KB6LTY in California. AO-85 was in safe mode earlier in the day but was operational for two afternoon passes over DM31 - three QSOs on a 6-degree pass to the northeast, and 4 more QSOs with stations in the western USA on the later 52-degree pass. I had other passes on AO-7, CAS-4A, CAS-4B, and FO-29, wrapping up with an FO-29 pass just before 0100 UTC as the sun was setting behind the hills west of the visitor center.

Before the last two passes I worked (CAS-4B at 0037 UTC, followed by FO-29), I was visited by yet another U.S. Park Ranger. This ranger was preparing to patrol a remote part of the national monument and was getting his gear in order as he checked on me. We were talking about radios initially, the radios I had on the roof of my car, and the radios in the ranger's truck. The conversation turned to the equipment on his belt and vest (mostly a utility vest, but with heavy bulletproof plates in front and back). I missed part of one pass, and completely missed another pass when we were chatting. Not a bad thing, as the rangers made sure I was okay during the afternoon. Other people who saw me in the same spot for many hours also asked if I was okay. I assured them I was fine and was taking advantage of the great weather to play radio as they were hiking around the national monument.

After the last FO-29 pass wrapped up after 0100 UTC, I packed up my equipment under the remaining daylight. I made a quick drive south to the border for some additional pictures of the border crossing, and to make a couple of phone calls (coverage was better at the border crossing than near the visitor center). After that, I made the drive home in about 3 hours. I drove 358 miles out to DM31 and back, with good weather.

I worked 27 passes on 11 different satellites: eight passes on all four FM satellites (AO-85, AO-91, AO-92, and SO-50); eleven passes on 5 different SSB satellites (AO-7, CAS-4A, CAS-4B, FO-29, XW-2A), and five passes on two orbiting packet digipeaters (FalconSat-3, ISS). I logged at least one QSO on 23 of those 27 passes, leading to a total of 103 QSOs from this DM31 day-trip. AO-91 had the busiest passes, where I logged 12 QSOs on each of the two passes I worked. AO-92 wasn't far behind with 22 QSOs. I worked more passes on CAS-4A (four) than any other satellite from DM31. I worked stations all over the continental USA, and a few other countries (Canada, Costa Rica, El Salvador, Mexico, and Panama).

Until my next trip to DM31... 73!

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